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## **1988 Ship Production Symposium**

### **Paper No. 11B: Applying Group Technology (GT) to Increase Productivity in a Job Shop Environment**

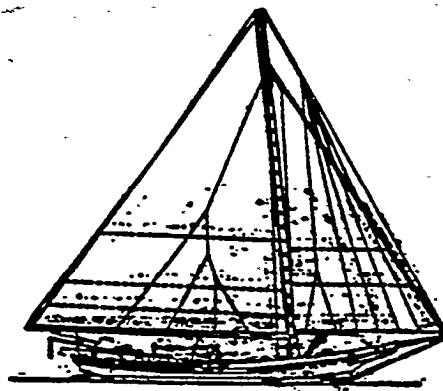
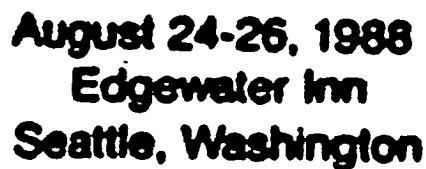
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Applying Group Technology (GT) to Increase  
Productivity in a Job Shop Environment No. 118

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ABSTRACT

Decreasing the high cost of small lot production in a job shop environment is a continual problem for shipyard shops supporting extensive repair and overhaul work. In the past, reducing cost in this area has been a desirable, but mostly unattainable goal. However, continued development of computer solutions to manufacturing problems utilizing Group Technology methods has made significant savings in this area possible.

BACKGROUND

Mare Island Naval Shipyard, located about 40 miles NW of San Francisco in Vallejo, CA is the oldest naval shipyard on the Pacific Coast. Established in 1854, Mare Island has a rich heritage that spans most of the Naval conflicts the United States has experienced. During its 134-year history, Mare Island workers have broken record after record in building and repairing naval ships. Yet, by the early 1980's it was apparent that past history was worth very little in the competitive business of a shipyard. In 1972, new construction had ceased, and then in recent years, with competitive bidding between private and public shipyards becoming a way of life for naval ships overhauls, new anxiety was introduced. Mare Island and the other public shipyards could no longer rely on the high quality of their work to guarantee overhauls. They would have to find a method not only to continue to produce quality work, but also to do it at a price competitive with private industry.

In October 1984, two general foremen from the large machine shop, in an attempt to find manufacturing methods more competitive with private industry, attended a Department of Defense, (DOD) sponsored workshop on Computer Aided Process Planning (CAPP), held at Brigham Young University in Provo, Utah. They left this workshop convinced that CAPP and the related

capabilities of Group Technology (GT) held the key to lowering cost and improving the productivity of the machine shop. Upon returning to Mare Island, they shared their findings with the machine shop superintendent, and he also became convinced that GT and CAPP held the key to lower cost.

IMPLEMENTATION-APPROACH

In January 1985, the Machine Shop Superintendent met with the head of Production Engineering and set in motion the implementation of GT and CAPP, into the Machine Shop operating scheme. A Group Technology (GT) team was formed consisting of (1) Machine Shop General Foreman, (1) Machine Shop Foreman, and (1) Industrial Engineer. None of these individuals had previous experience with GT or CAPP, so there were no preconceived ideas of what GT or CAPP should do for the shop. The team recognized that the Machine Shop exhibited job shop characteristics. Many "one of a kind" and small lots are produced, and the demand for a given part cannot be forecast until an order is received. The team was also aware that the average skill level of the machinists in the shop had been decreasing since new construction ceased in 1972. The task then was to learn how GT and CAPP could improve productivity in this environment. The first step taken by the team, was to become educated in the area of GT and CAPP. Society of Manufacturing Engineers (SME) seminars provided this education, giving the team a foundation of understanding on which to build a unique application, specifically designed to meet the needs of the large machine shop.

APPROACH

It is usually accepted by industry that a job shop has little potential for productivity improvement. High set up cost, small lot size and resulting high cost per part are characteristics of this environment. Most decisions concerning how to manufacture a part

are left up to the machinist doing the work, and historically, very little effort has been expended to find a more productive method. However, as the GT team learned more about GT and CAPP, they found that the current goal for GT based systems is to provide data and tooling that will allow economical production of parts in lot sizes of 1. In parallel with formal training, a serious effort was made to find companies with a manufacturing environment similar to Mare Island who had successfully implemented GT and CAPP. Individuals associated with manufacturing concerns both inside and outside of the Federal Government exhibited a willingness to freely share their knowledge. The help that these people gave saved the team hours of work that would only have duplicated the efforts of others. Many of the people contacted were able to suggest additional referrals, and almost two dozen installations were visited, contributing valuable information to the team's investigation.

#### DEVELOPMENT

As the capabilities and possibilities of GT and CAPP were gradually learned, ideas and goals relating to Shop 31 began to take shape. The advantage and opportunity provided by coding of parts and grouping them into families was evident. If the GT program could search the coded parts and find enough parts manufactured in a similar way to form a family, then a standardized process plan could be developed for that family. Instead of starting from scratch each time a member of the part family was to be manufactured, the planner could start with the basic process plan and adapt it to the specific part required. This capability would require the installation of a GT system and an adaptive (variant) process planning system.

The team observed demonstrations of generative process planning systems during the formulative stages of the application concept for Shop 31. But they realized that a generative CAPP system that would automatically create a complete process plan based upon the descriptive features of a part would need access to complete data bases containing extensive machine tool parameter data, material data bases, tooling data bases and others. These data bases do not exist. It will take years to develop them. It is generally agreed that they should be developed, but until they are developed and until Shop 31 planners are ready for such an advanced system, variant process planning can be used to gain significant productivity gain.

#### ADDITIONAL REQUIREMENT

During the formulation of the plan for improving Shop 31, a significant problem surfaced that had little to do with GT or CAPP. Because two of the team members had extensive experience in the shop, they were concerned that the drawings issued to the machinists were not adequate for manufacturing the parts. Further investigation of this problem showed that it was even bigger than first suspected. Machinists were having to spend excessive amounts of time going to shop plan files verifying dimensions, tolerances, and material specifications. In many cases, the machinist would find it necessary to draw a separate sketch of the part to be made because the issued drawing was of such poor quality and because many dimensions often had to be transferred from a table to the drawing. What the machinist needed was a drawing containing only the part he was to manufacture with all necessary material tolerance and manufacturing notes. After considerable research, it has been determined that the best way to supply the machinists with the needed drawings is by electronically scanning the aperture cards that contain the required drawing information. This allows the drawing and notes to be viewed at a computer terminal, "here a new single part drawing can be created by electronically cutting and pasting from the scanned input. The new drawing can then be stored, and at any time output to a printer, and then be issued to the shop floor with the process plan.

#### LONG RANGE - SHORT RANGE

As the overall needs in the shop continued to be defined, it became clear that both a long range and a short range approach had to be implemented in parallel. The long range approach could look 5-10 years ahead and be somewhat idealistic, but it had to accommodate the short range 2-4 year plan which had to correct the areas of the most serious problems. The short range plan had to be practical and achievable, providing a good foundation for future improvements. Four elements of the short range plan were finally defined. First would be a scanning and editing system to provide quality drawings to the machinists, second would be a Group Technology System to provide visibility of the entire scope of the parts being made, third would be an Adaptive computer Aided Process Planning System, and fourth, retention of the current Machine Shop Tracking system (MSTS). MSTS monitors the location of a part as it passes through the shop. At first, these elements were discussed as individual systems

being networked together, but later it was realized that each of capabilities should be integrated into a single, expandable system. This system would be a first step capable of growing into tomorrow's requirements.

#### IMPLEMENTATION CONSIDERATIONS

In figuring budget calculations for this system, a payback time of 2 to 4 years was calculated, depending upon the variables introduced. However, it takes 18-24 months after procurement to install and implement such a system, and the initial cost is several hundred thousand dollars for the hardware and software alone. This resulted in two concerns. First, will it work? Are there enough similar parts in Shop 31 to establish part families and manufacturing cells? And second, how can enthusiasm for the system be maintained during the long procurement and implementation cycle?

The first concern was addressed by the team in two ways. First, following a suggestion obtained at a seminar they attended, the team chose at random 300 recently manufactured part numbers and obtained standard drawings of these parts. Each standard sheet of drawings contains several parts. The team then divided up the drawings and using "cut and paste" methods constructed "B" size individual drawings of each part. The individual part drawings were then visually grouped by shape, observing that the materials the parts were made of were at least similar. It was observed that more than 60% of the parts sampled exhibited significant similarities to one another, and in fact 7% of the samples were either identical parts or close enough to share identical manufacturing processes. This first effort provided full support for the original purpose of this project.

The second effort to prove the usability and effectiveness of the GT-CAPP System in the machine shop, involved purchasing an AT compatible computer and software package called DCLASS. DCLASS is a Decision Tree Management System (DTMS) that can be used for Group Technology and Computer Aided Process Planning as well as a variety of other decision-based applications. By purchasing DCLASS PC, the team is able to test the full scale capabilities of a large whole shop system at a fraction of the cost. Testing in GT, CAPP and Material Specifications continues to confirm the need and applicability of a large whole shop system to reduce production cost.

#### GETTING THE CELL BEFORE THE SYSTEM

In conjunction with confirming the applicability of a GT-CAPP system in the shop, the secondary concern for maintaining enthusiasm for the system over a long period of time had to be dealt with. It was recognized that displaying computer programs, sorting part drawings, and other relatively low profile activities do not provide tangible, interest grabbing, visible objects around which to maintain enthusiasm. What was needed was a successful, operating cell right in the shop, but a cell would be the result of a GT system, not a forerunner to it. However, several occurrences made it possible to pursue not only one, but two cells for installation into the shop prior to the installation of the GT system.

The two cells are at opposite ends of the automation spectrum. The first cell, a "fastener cell" developed at Mare Island, utilizes only conventional machine tools. This cell was defined by the GT team using manual methods to establish a part family and is expected to be operational by April 1988. The second cell, a "RISIC CELL" developed by the National Bureau of Standards (NBS) is totally automated and is designed to operate for full 8-hour shifts untended. The RISIC CELL is expected to be installed and operational by October 1988. (see Figs. 1 & 2)

The efforts required to implement these two cells have been effective in creating and maintaining enthusiasm in management and on the shop floor and have helped focus attention on improving the overall way business is conducted in the machine shop. The only detrimental results from the cells is some confusion and extra explanation as to how the cells were defined without having a GT System in place. The team has to explain that the "Fastener Cell" is not based on an optimum part mix, but on a reasonable part mix determined by experience and limited vision of the various possibilities. It is expected that even though the cell was defined in a rather crude fashion, it will be effective in demonstrating advantages of cellular manufacturing. After the GT system is implemented, it will be possible to re-evaluate and optimize the part family.

The "RISIC CELL" was defined when the General Foreman on the GT team recognized the RISIC parts as an "obvious" part family with 4 distinct parts manufactured in 12 different sizes. The National Bureau of Standards, Automated Manufacturing

Research Facility (AMRF) was looking for such a family around which they could implement the automated cell technology developed over the last 5 years at the ARMF. However, the RISIC family will not be able to keep this cell loaded. The GT system will be needed to determine additional parts that should be in this family. In actual practice, the GT system will be used as the primary tool to conduct an ongoing evaluation of all manufacturing cells both operating and proposed.

business requires long term commitment and innovative ideas to adapt the rigid guidelines of the "expert" to the needs of one's own shop.

#### MOVING FORWARD

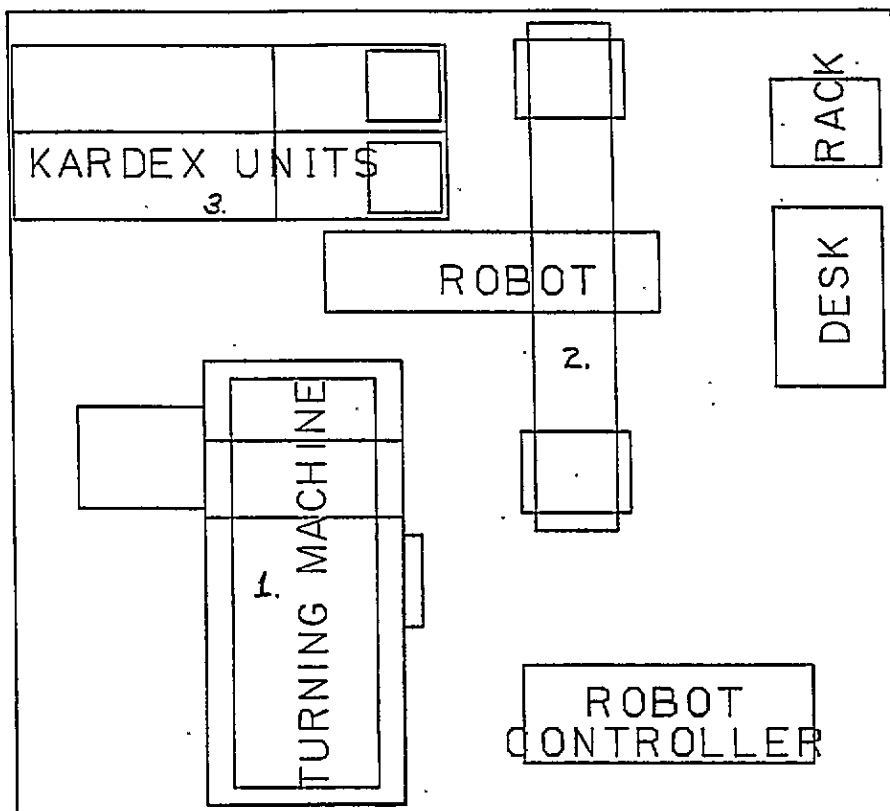
Introducing Cells onto the shop floor is time consuming, and it dilutes the effort of the GT team. However, it has provided additional "beneficial results" in maintaining the momentum of the project. To obtain computer equipment like the GT System in the Naval Shipyard environment requires a ponderous mass of bureaucratic, dead end paperwork that takes months of effort for each step taken. In addition, pressure to reduce spending at all levels has made the acquisition of funding a time consuming, difficult task. But, by being able to utilize the cells as visible results of the project, progress has continued to be made.

The current effort centers around purchasing and implementing the scanning and editing portion of the system. It is hoped that by summer 1988, this part of the system will be in place. At that time it is also anticipated that the main computer on which the system resides will be installed.

While the main computer is scheduled to be installed prior to October 1, 1988, funding for the GT and CAPP software will not be available until after October 1st. Once the system is operational with the capability to code parts, the part data base will begin to be built. The plan is to build this data base, part by part. It will take from 12 to 24 months before sufficient data will be available to start constructing useful part families. This method of building the part data base might at first seem to be inefficient, but investigation has shown that the data currently available is insufficient to establish any kind of part history. One of the benefits of this system that really isn't being considered in the economical analysis is that accurate shop history will be available for future decision making.

The work has only begun, although a lot of energy has already been expended. But the message is clear. To implement new technology at a level that changes the way a shop does





1. TURNING CENTER - WARNER SWASEY 12 inch with live tooling
2. ROBOT - WESTINGHOUSE, UNIMATE 6000
3. KARDEX UNITS - KARDEX MATERIAL STORAGE MODULES

FIGURE 1. "RISIC CELL" LAYOUT

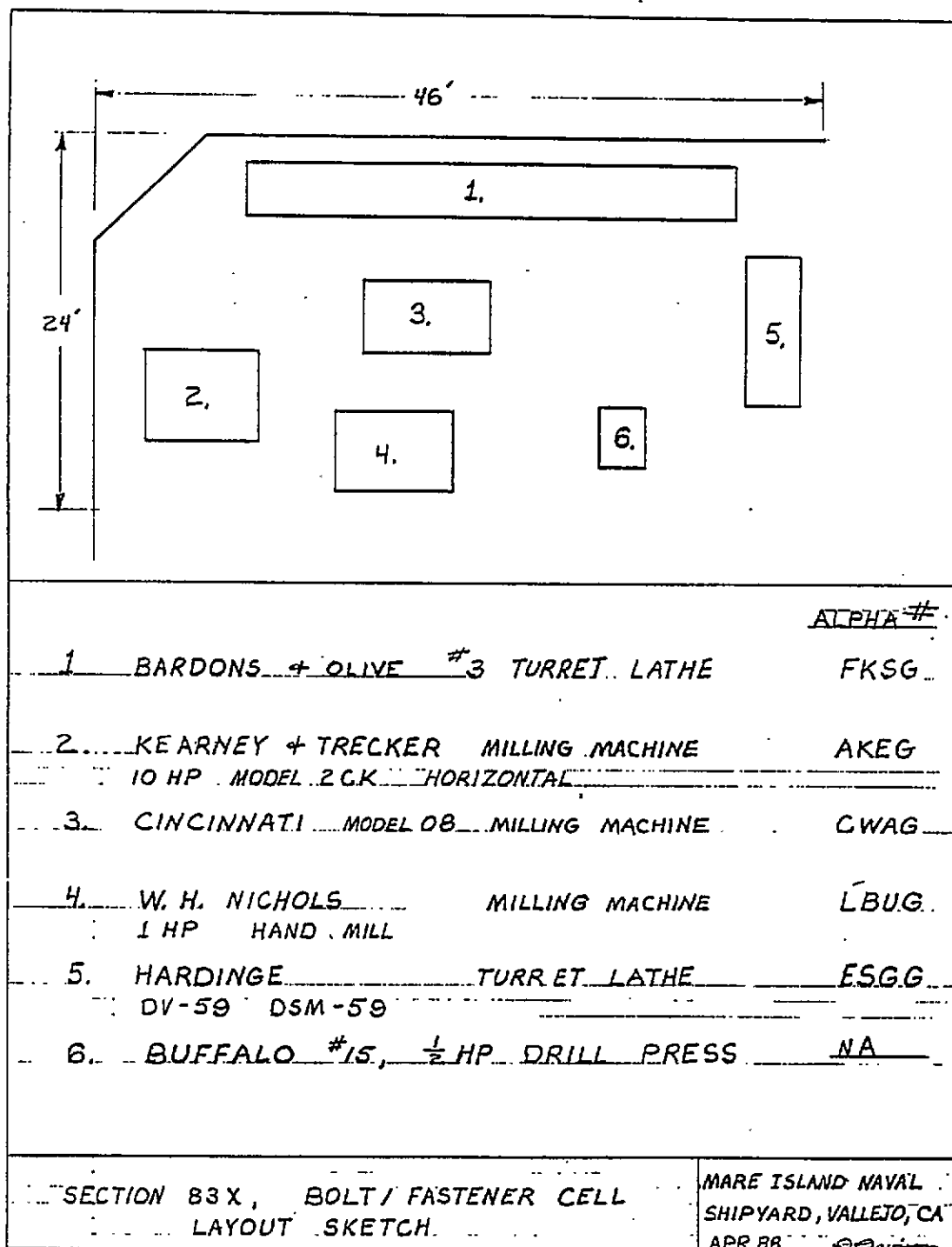


FIGURE 2

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